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CONTRACT FOR LONG MARCH ROCKETS TO LAUNCH U.S. IRIDIUM SATELLITES ALREADY IN EFFECT

Guo Chun

On 28 April 1993, the China Great Wall Industry Coporation and the U.S. Motorola Co. signed a satellite launch services contract in Beijing--that is, to use Chinese improved model Long March 2C carrier rockets to launch multiple Iridium satellites. The contract in question went into effect on 30 July 1993. The first technological satellite and rocket coordination meeting was held during the middle ten days of August in Beijing, thereby pushing the button on the entire Iridium satellite engineering implementation.

The engineering associated with the Iridium satellite global mobile communications system (simply called the Iridium system) is a high science and technology project in the realm of communications which spans centuries and leaps across national boundaries. After the system in question is constructed, any Iridium system user will be able, in all cases, to make use of hand held type radio telephone devices or Iridium system terminal equipment to talk directly to any place on earth at any time. Therefore, it has also been called an individual mobile communication system (including speech, digital transmission, facsimile, and paging). Without any doubt at all, the establishment of the system in question will obviously improve the status of global communications, including China in that. In the 90's of the 20th century, it is possible to open up a new era in the realm of individual wireless communications.

The Iridium system was formally put forward in 1990 by the U.S. Motorola Co. after going through many years of research and empirical demonstrations. The original design concept of the Iridium system as a whole is similar to the atomic structure of the metal atom iridium. Outside the nuclei of iridium atoms, there are 77 electrons moving around them. Moreover, the original design of the Iridium system was also 77 small model communications satellites revolving around the earth, very similar to the structure of iridium atoms. As a result, the name Iridium system was adopted. Later, the overall design was changed, reducing it from 77 satellites to 66 satellites. However, the name Iridium staid the same as before. The company managing this system was also called the Iridium Co.

Fig.1 Iridium Satellite Launch Service Contract Signing Ceremony [Banner] Chinese Great Wall Industry Coporation U.S. Motorola Co. "Iridium" System Satellite Launch Services Contract Signing Ceremony

The Iridium system is composed of two parts--a surface section and a space section. The space section is composed of 66 small model communications satellites moving in 6 polar, near earth, and near circular orbital planes. Each orbital plane has 11 satellites uniformly distributed on it. Due to the fact that Iridium system satellites are relatively low off the earth's surface--only something over 400-500km--they are approximately 60 or 70 times lower than the current geosynchronous satellites. Therefore, radio communications are very strong. Individual hand held type radio telephones very easily acquire clear signals and speech. The Iridium system's surface phase, by contrast, is composed of such /9

things as system control centers, juncture stations distributed in various user nations and areas of the world, as well as terminal equipment, and so on.

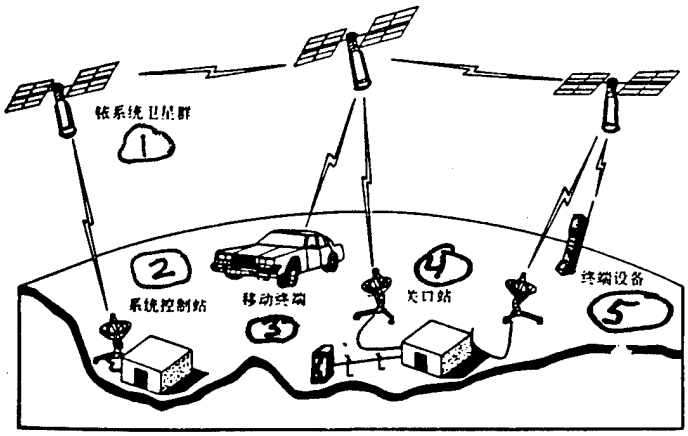

Fig.2 Iridium Satellite Global Mobile Communications System
Key: (1) Iridium System Satellite Group (2) System Control Station (3) Mobile Terminal (4) Juncture Station (5) Terminal Equipment

The Motorola Co. and the Iridium Co. are two companies which are legally independent of each other. The former created the Iridium Co. in order to set up the Iridium system with its global range. The Iridium Co.'s mission is to seek out contracts with a world wide scope, absorb investment form large companies in the many nations and regions in the Americas, Asia, Europe, and Africa, and, in conjunction with this, jointly manage global communications and turn them into a transnational limited stock company. Therefore, beginning on 30 July 1993, the Iridium Co. split off from its mother company to become a company set up in the U.S. On 2 August 1993, the Iridium Co. announced that it had signed a contract with the Motorola Co. In the next 5 years, the Iridium Co. is using 3.4 billion U.S. dollars to purchase space systems associated with the Iridium system (including the entire satellite space network and its surface control system). Within the 5 years after 1998, another 2.8 billion U.S. dollars will be spent to purchase maintenance and management associated with the systems in question. The Motorola Co., by contrast, takes responsibility for organizing and setting up the Iridium satellite system. It signed-

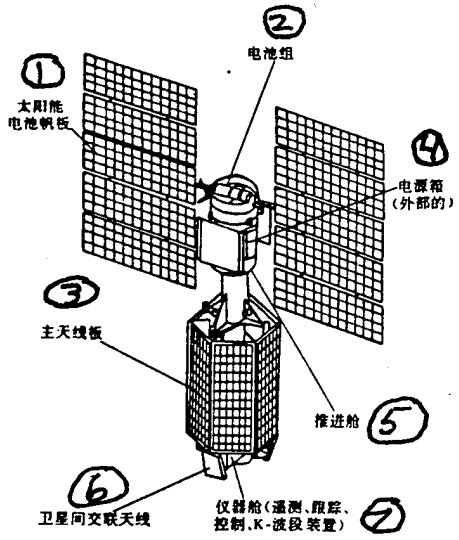

Fig.3 Overall Iridium Satellite Structure

Key: (1) Solar Energy Battery Panels (2) Battery Set (3) Main Antenna Panel (4) Electric Power Source Box (External) (5) Propulsion Module (6) Cross Connection Antenna Between Satellites (7) Instrument Module

(Telemetry, Tracking, Control, K-Wave Band Systems)

together with the China Great Wall Industry Corporation, the U.S. McDonnell Douglas Co., and the Russian Khrunichev Co.--an Iridium satellite launch services contract. The first Iridium satellite will be launched by China in 1996. After that, concentrated launches will be carried out in turn by the launching companies of the three nations, forming the space network of the Iridium system.

In conjunction with this, they will be turned over to the Iridium Co. The network in question will go into operation in 1998, supplying services to users all over the world. As a result, it is possible to say that the Iridium system is also a world class systems engineering project.

The Motorola Co. and the Iridium Co. declared in a communique on 2 August 1993 that the first 800 hundred million U.S. dollar round of financing plans had already been announced to be completed. There were 12 communications conglomerates and industrial companies from 9 countries participating in the first period of investment. Among these, the companies associated with the nations of the Americas were Bell Canada communications group (its annual volume of business is approximately 15.6 billion U.S. dollars), Venezuela's MURIDIRI investment group, and the U.S.'s

Lockheed Co., Thor space technology and electronics company, Sprint communications company, and the Motorola Co. (the annual volume of business is approximately 13.3 billion U.S. dollars). The companies and nations of Europe, the Middle East, and Africa were Saudi Arabia's MAWARID group, Russia's Khrunichev space industry company, and Italy's STET communications group. The nations and companies of Asia were Japan's Iridium group (taking DDI as head, it is a group composed of 18 Japanese companies including such ones as Mitsubishi, Sony, and so on, as well as 7 regional cellular telephone companies), the China Great Wall Industry Corporation, and Thailand's Consolidated Telephone Co. Besides these, there are also companies from a number of nations that are in the process of holding talks on investments.

The Iridium system has at present already entered into the full implementation stage. The clear objective is not only to create a new era of individual wireless communications, but--what is even more important--once this system goes into operation, it will attain astonishing economic benefits in the realm of mobile communications.

Xu Ting

The U.S. Strategic Defense Initiative Office (SDIO, currently the Ballistic Missile Defense Office) has already announced the status of funding allocations associated with it fiscal 1994 budget request. These funds will be primarily used in 4 areas--that is, theater missile defense (TMD), limited defense systems (LDS), research and support projects, as well as follow on types of technology, and so on. The status of specific allocations is as follows.

In theater missile defense projects, investments with regard to ground based radars (GBR) are 234 million U.S. dollars. These funds will be used in continuous empirical verification/evaluation of ground based radars, radar manufacture and testing, completion of a set of designs for combat evaluation systems, key design evaluation and review, as well as continuous implementation of solid state verification of array technology contracts, and so on. As far as ground based radar systems are concerned--in the LDS area--there is funding for another 100 million U.S. dollars.

SDIO applied for 249 million 800 thousand U.S. dollars of funding for the PAC-3 Patriot project to be used in carrying out PAC-3 model Patriot missile hardware and software development and testing, to complete propellant, casing, and engine development and testing, to carry out warhead development and testing, as well as to begin to carry out the overall assembly and testing of PAC-3 model Patriot missiles.

The budget request for the Light Model Extra Atmospheric Projectile (LEAP) project was 93.8 million U.S. dollars to prepare to carry out one Xiaoliequ (Small Hunting Dog) missile flight test, one iteration of LEAP interceptor flight tests making use of solid propellant, as well as one interception test against a theater missile defense target launched from a warship.

The Intelligent Eye project acquired an appropriation of 112.5 million U.S. dollars used in order to complete flight verification system initial design evaluation and review as well as to purchase components needed for satellite flight verification. In the LDS arena, the investment with respect to Intelligent Eye was 140 million U.S. dollars.

The investment for Theater High Altitude Air Defense Systems (THAAD) was 482 million U.S. dollars, used in order to carry out final design evaluation and review, hardware tests and test flights begining in 1994, as well as tests of launch systems and battle management/command, control, and communications systems (BM/C3). The U.S. Navy and Marine Corps TMD projects won 159 million U.S. dollars in appropriations, used in order to continue the implementation of spy radar design, the improvement of Zhousidun (phonetic) weapons control systems, Zhousidun (phonetic) counter jamming tracking tests, as well as the Navy's BM/C3 system design work.

The appropriation for the Enhanced Range Interceptor (ERINT) project was 97.6 million U.S. dollars. It is used in order to verify the collision kill and damage capabilities of the systems in question with regard to moving targets and to carry out Patriot/ERINT integration and flight test projects. The Arrow follow on model (ACES) project acquired 56.4 million U.S. dollars

in funding to carry out 3 iterations of Arrow-2 missile flight tests. Such activities as guaranteeing the installations needed for ERINT, Patriot, and THAAD target flight tests, HERA booster system verifications, as well as Minuteman missile, STARS booster, and the Navy's TBM project obtained funding of 64 million U.S. dollars all together.

Under LDS plans, ground based interceptors (GBI) obtained 238 million U.S. dollars of funding, used in order to carry out verification/evaluation of ground based interceptors, preliminary design reviews, as well as to purchase products produced as necessary prerequisites during ground based interceptor tests. The investment in command centers was 76.3 million U.S. dollars, used in completing Block 1A design demonstrations and system engineering assembly verifications/evaluations as well as Block 1B BM/C3 systems.

The costs associated with detector research projects were 83 million U.S. dollars, used in order to complete surface system tests associated with mid phase detector testing projects and to carry out overall system assembly and tests on containerized satellites associated with space shuttles (SPAS 3). Besides this, under LDS projects, such items as systems engineering, target recognition, national testing platforms, system threats, as well as

targets, and so on, obtained, respectively, funding of 49.6 million U.S. dollars, 68 million U.S. dollars, 53.7 million U.S. dollars, 10 million U.S. dollars, and 85 million U.S. dollars.

In the areas of research and support, scientific and technical innovation projects obtained 50.4 million U.S. dollars, used in order to implement large numbers of research projects. The investment in electronic jamming projects was 22.3 million U.S. dollars, used in order to carry out research associated with Intelligent Eye, ground based radars, and ground based interceptor sensitivities. Appropriations for intelligence threat projects were 10.02 million U.S. dollars.

In the area of follow on models of technology, detector integration projects obtained 29.3 million U.S. dollars in order to carry out useful load and carrier rocket final checks as well as to complete the first detector integration deep space flight mission of Kelaimendinuo (phonetic illegible) I. Interceptor integration projects obtained 49 million U.S. dollars, used in order to develop and test Mini Guidance Head Technology Integration Satellites (MSTI) 3 and 4, to maintain MSTI 2, 3, and 4 in orbital flight, as well as to carry out advanced detector flight verifications.

The 59 million U.S. dollars for chemical laser projects is used in continuing to carry out the production and delivery of Alpha and LAMP composite test devices. The 25.5 million U.S. dollars for neutral particle beam projects is used in order to complete continuous wave deuterium verifications. Other funding includes 11 million U.S. dollars for ATP/FC appropriations, 22.4 million U.S. dollars for kinetic energy boost phase interceptor appropriations, as well as 73 million U.S. dollars for advanced interceptor technology appropriations.

SDIO also requested 267 million U.S. dollars in operation support outlays and 2.7 million U.S. dollars for military construction costs. (Xu Ting)

THREE TYPES OF MOBILE SATELLITE COMMUNICATIONS SYSTEMS OUTSIDE CHINA

Wang Jingquan

Although satellite communications services have already attained wide spread applications, up to the present time, however, they have still not provided mobile radio service (MRS) which is inexpensive and capable of serving many markets. The principal obstacle to supplying this type of service is still technological problems. It requires high level communications satellites and their advanced technology, inexpensive mobile user terminals, and so on. In the early 1970's, there were expectations for a number of mobile communications satellite systems. It is only now, however, that we are prepared to set up the technological capabilities of this type of system.

Archimedes Satellite System

In Europe, a good number of nations have all carried out similar research with regard to MRS--for example, the U.K. technology satellite (T-SAT), the French polar region orbiting mobile communications satellite (SYCOMORES), as well as Germany's stationary ring design (LOOPUS) which is maintained occupying orbit by nonstationary orbit satellites, and so on. After the European space agency goes through combined research, it will possess an integrated system called the Archimedes satellite system. Research clearly shows that this type of high angle of inclination elliptical orbit satellite constellation has definite advantages over conventional geostationary orbit satellites.

The putting forward of the Archimedes satellite system is in order to effectively satisfy requirements associated with the growth of mobile radio services. Precisely specifying this target is very important. First of all, it is possible to carry out qualitative and quantitative research with respect to the business market. Second, it is possible to get clear the benefits of the surface systems in order to realize maximum benefits associated with satellite systems.

Mobile radio services markets can be divided into two types. One type is unidirectional services associated with speech broadcast, data broadcast, speech narrow band broadcast, data narrow band broadcast, and so on. Another type is bidirectional services associated with mutual type speech and data services.

One of the primary factors spurring the putting forward of the Archimedes satellite system is the development of the speech broadcast market. The first broadcast companies made use of monotonic amplitude modulation systems. Signals were sent out on quite low frequencies, using very simple receivers to receive them.

The appearance of the recording of stereo music also spurred the broadcast companies to go through an entry into the broader business of stereophonic frequency modulation. However, it required relatively high frequency bands, comparatively large band widths, and, in conjunction with that, increased receiver complexity. Most recently, broadcast companies have shown that they are thinking of introducing digital audio broadcast (DAB) in

order to further improve audio quality. Besides this, broadcasting companies have also expressed the need for even more channels and coverage of the whole of Europe. Comparing this to the former requirements, it simultaneously demands, at the present time, even higher transmission capacities and even broader coverage. The Archimedes satellite system, which has already been designed, can satisfy these requirements.

Broadcasting is not only a medium for the transmission of music but also for information. This can be called multiplication services (VAS). Such information as early network news broadcasts as well as weather forecasts, and so on, were all made into programs with accompanying sound harmonics. After that, new technologies were put forward where multiplication serivces were sent out on secondary sound accompaniment carrier waves. The secondary carrier waves in question correspond--speaking in terms of main sound accompaniment signals--to being able to receive noncontinuously. In this way, it is possible to make multiplication services take actual user sets as targets. Following along with the introduction of digital sound accompaniment broadcast services, it is possible to allocate for multiplication services one portion of digital bit flow, thereby making it carry more information than analog technology. When used in mobile services, multiplication services--also called routed transmission information services (RTI)--to represent an important and rapidly growing mobile radio services market. The Archemides satellite system primarily serves this market.

As far as bidirectional mobile radio services are concerned, at the present time, services are supplied by two means--surface systems and satellite systems. In most of the countries of western Europe, the surface cellular networks which exist at the present time already approach coverage of all the countries. However, they are meeting with problems of lack of capacity. The introduction of technologies associated with pan European mobile services systems (GSM) and digital type special purpose communications networks (PCN) promoted the resolution of this question. However, with regard to coverage of all possible users, it will only be after a good number of years in the future that it will then be possible to realize this. It is still a target which is not very clear.

In another realm--that is, the field of maritime satellite services--there is a requirement to realize global mobile communications through satellite systems. However, capacity deficiencies are too great. Moreover, maritime satellite systems--at the present time--only occupy one very unimportant place in the mobile radio system market. However, this is still not an important problem. The important problem is whether or not international maritime satellites systems have the capability to provide inexpensive terminals for services and activities associated with a broad range of people. As a result, between these two systems--surface and space--there is a possibility to supply services through the Archimedes system to a vast market. This market, which is composed of mobile services, requires audio and data services with a pan European range. It not only provides

service for individual communications. It also serves application activities associated with agencies and groups such as high level government, companies, and so on.

Table 1 gives predicted Archimedes market scope, estimated mobile terminal market prices, as well as estimates of annual income obtained from various types of services.

The benefits discussed below are universal in all mobile satellite communications systems. There is not need for large model ground installations. Compared to surface systems, satellite systems are able to provide more advantageous propogation environments and are capable of supplying to radio systems faster, broader, and larger coverage. This is because--whether one is talking about satellite or surface transmission--there is a need, in all cases, to complete free space propogation. Free space propogation is also capable of severe attenuation due to interference between transmiters and recievers. Compared to /20 satellites, surface transmission will meet with larger satellite ecllipses. Moreover, the advantages of satellite transmission discussed above are also capable of being increased through methods to enlarge the angles of inclination associated with satellites and receivers.

Table 1 European Mobile Radio Services Market Predictions for the 1990's

Services Type	Services Amount (Terminal Needs) (Unit)	Terminal Price (U.S. $)	Annual Service Charges Per Terminal (U.S.$)
Digital Radio Routed Transmission Data	100 million	100-200	10-20
Private Telephone	10 million	100	20-200
Office Services	1 million	500	200-1000
	100 thousand	1000	1000

Table 2 Statistical Results Associated with Utilization Rates of Ellipsat System

Angle of Inclination	5°	15°
Coverage Rate		
Maximum (Best Position	100%	100%
Minimum (Worst Position)	95.6%	60.4%
Average	99.7%	89.5%

Ellipsat System

The purpose of the U.S. Ellipsat system is to supply satellite

radio positioning services and audio services in radio positioning services wave bands.

This low elliptical orbit Ellipsat system, which has a perigee that is only 426km and an apogee which is 2903km, is a 12 satellite constellation. Through 2500 individual points on the U.S. mainland, calculations were made of utilization rates associated with its 24 movement periods (see Table 2).

Making considerations from the perspective of capacity, 18 satellites will be deployed. There are two types of deployment plans. One is to add 3 satellites to each orbital plane. In this way, at all locations on the U.S. mainland, predicted utilization rates will exceed 99%. Another plan is to add at least 6 satellites in equatorial planes--that is, 6 satellites utilizing each plane--a total of 12 elliptical orbit satellites in two planes and 6 equatorial orbit satellites in order to cover the whole globe.

As far as the addition of equatorial satellites is concerned--besides shrinking southern hemisphere coverage gaps--it is also capable of increasing service capacity to the northern hemisphere, thereby leading to effects associated with supplementing northern hemisphere satellite constellations.

The Ellipse positioning system only requires putting in a part of the expenses for a whole system. It is then possible to set up radio positioning services (RDSS). Ellipse opts for the use of Massachusetts research institiute (MIT)'s technology design called the stationary signal beacon system.

Stationary signal beacon systems carry out comparisons with regard to differences in arrival times (TDOAS), realizing range finding. Through making use of arriving frequency differences FDOA to do measurements, the precision and speed of positioning measurements are increased. FDOA is a very unique technology associated with Ellipse RDSS. The role of this type of technology is to provide service with low input. Moreover, in the area of resources, it is also capable of causing excess parts of capacity to be used in other services--for example, audio services. As a result, systems can be effectively be used in two types of services.

The Ellipse satellite system stationary signal beacon system is a high precision design. It opts for the use of traditional range finding methods which are equivalent to the signal time differences reaching two or more satellites (of course this also includes frequency difference data).

Positioning computers associated with TDOAS to ground control systems provide possible location lines. FDOAS supplies lines intersecting with them. The intersection points of these two lines are nothing else than the actual locations of mobile transmiters. Positioning precisions depend on satellite positions and numbers--including the number of samples and the actual sampling processes associated with each unit time period when relaying the same sample signal. Making use of these parameters and actual measurements--opting for the use of the same type of methods--it is said that Ellipsat systems are capable of being designed to become systems

with relative positioning precisions of 100 meters.

With regard to situations where only one satellite is positioned in fields of view, the positioning measurement process is to carry out one iteration of TDOA measurements. After waiting a certain period of time, carry out a second iteration of measurements with regard to this satellite when it is already located in a different position. This type of satellite position is already known. In conjunction with this, assuming that mobile unit positions have not given rise to great changes. Mobile unit positions can then be precisely determined. It is just that precisions will be somewhat lower than those making use of two satellites.

Ellipsat audio service is distinctive. This service provides continuous coverage satellite service (mostly in coastal areas) at lower cost than cellular service. There are no other systems--no matter whether one is speaking in terms of systems which are put forward or just in the process of design--that are capable of reaching this type economic objective. This investment structure--associated with the system in question--is primarily based on setting up optimum satellite constellations.

Ellipse audio services provide one type of intergrated, transparent, and seamless transition means from code division multiple address cellular to satellite services. In normal situations, code division multiple address digital cellular precontracted subscribers make use of cellular telephones within the service area. However, when users wander outside the areas in question, use is made of additional equipment on board satellites, cutting over to satellite communication modes. This set of equipment--called Ellipse cellular--takes signals from cellular frequencies and transforms them to Ellipse frequencies. All processing equipment (audio) and support equipment (hand sets and base band equipment), etc., is interchangeable with respect to both cellular and satellite modes. Code division multiple address technology is also capable of making this system complete this combination because encoding technology itself can give rise to neutalizing inversion effects between transmission (radio frequency) and processing (audio frequency). Due to the fact that Ellipsat operates in low earth orbit, there is not only very little satellite delay. Moreover, transitioning from cellular to satellite operating modes, users have almost no "awareness".

Telephone service from mobile users to fixed users is to first take user audio and transmit it to the Ellipse satellite which is in the optimum position at that time. After that, the satellite in question takes digital audio information and relays it to the /21

surface control station for the area. Then, making use of the telephone exchange facilities, signals are taken and encoded into the telephone exchange network. Making use of this system--even if one is speaking of mobile users in any distant region of the U.S.--they are capable in all cases of communicating with any telephone network in the world.

Audio conversations between mobile users and mobile users are

supported by dual jump satellite system links. Due to the low heights of satellite orbits, it is estimated that there are no unacceptable time delays.

As far as linking up between public networks is concerned, through opting for the use of Ellipse signal system design, it has been made very convenient. It basically opts for the use of 7 layer signal transmission systems (SS7), and sets up common use channel signal transmission technology. This is world class high technology service. This type of path allows the supplying of such high level services as "call initiating user identification". The calling telephone number is identified at the receiving terminal. Speaking in terms of mobile communications, it possesses characteristics with great practical utility.

COSCON Satellite System

Russia has put forward two satellite constellation systems. One is GONETZ (Courier) and is composed of 36 satellites. They have useful loads of 70kg and are low speed storage-transmission types of satellite communications systems.

The other is the COSCON system composed of 32 satellites. It is capable of supplying global range mobile and fixed communications services. In conjunction with this, it possesses positioning and navigation functions. It is capable of implementing global noncontinuous communications in areas above 60° latitude and possesses certain communications relays.

As far as opting for the use of direction finding methods is concerned, single satellites of the COSCON system are capable of providing positioning functions. Making use of this 32 satellite constellation, any user on earth is capable of carrying out all weather navigation and positioning.

COSCON satellites carry two types of transmiters. Among these each L frequency band transmiter unit is capable of supplying 400 bidirectional channels. Each UHF frequency transmiter unit provides 32 bidirectional channels. During use in mobile communications, user calls wait an average period of 3-4 seconds. The maximum waiting period is 10-15 seconds.

The catagories of mobile communications include bidirectional telephone, telegram, unidirectional digital data transmission and reception, stationary imagery transmission (no capability to transmit television) and can be specifically divided into:

--unidirectional, fixed period digital reception and propogation;

--dissemination of digital information in accordance with a single address;

--bidirectional telegram and telephone communications between users;

--stationary imagery dissemination;

--organic secure communications.

In the initial period, users were approximately 1 million. Within a 24 hour period, 70% of users were able to make 3 telephone calls, each lasting a few minutes.

The COSCON satellite system is also capable of providing coordinate locations for mobile users. Positioning precision is 200-400 meters. If option is made for the use of reference station difference positioning technology, positioning precisions are capable of clearly improving. System positioning time is 15-20 seconds. The missions which COSCON satellite systems are capable of completing are as follows:

--use in emergency communications associated with such things as natural disasters, emergency medical treatment, and so on;

--appropriate uses for small capacity individual mobile communications associated with special needs or emergency requirments;

--collection and dissemination of data from such systems as weather stations, earthquake units, banks, and so on;

--use in data exchange and data statistics between various types of bases and actual commerical, industrial, and business entities;

--data exchanges between various types of organizations and agencies and mobile teleprinter, telephone, facsimile, and so on;

--through fixed stations, mobile users being capable of setting up contact with other communication networks;

--communication by rare address circuits associated with fixed stations with communications that are not great;

--supplying low precision navigation and positioning services for mobile users.

FRENCH ASTRONAVIGATIONAL COMPANY AND GERMAN ASTRONAVIGATIONAL COMPANY PLAN MERGED MISSILE BUSINESS

Wen Hui

The French astronavigational company and the German astronavigational company figure on merging their missile businesses to form Europe's second largest missile weapons firm, thereby matching themselves in contention with the missile weapons company set up by France's Matela (phonetic) company and British Aerospace. At the present time, merger talks are already being carried out at high levels.

Acting as members of the European missile company, from 1972 onward, the two firms carried out cooperative efforts in the area of antiarmor and antiaircraft missile systems. This iteration of conferences will concentrate discussions on whether or not to expand a step further previous cooperations, setting up a combined company, and, in conjunction with that, drawing up anew the missile development plans of the two firms.

The primary missile weapons products of the French astronavigational company include: ASMP (nuclear), the Bandit, such air to surface missiles as AS30L and so on, the Flying Fish antiship missile, the Roland, a new generation of Sidewinder NG, as well as surface to air missiles belonging to the surface to air missile families of the future, and Milan, Teligaite (phonetic), Huote (phonetic), and Shamang (Sand Python) antitank missiles.

STRENGTHENING AIR DEFENSE MISSILE POWER

Hui En

During the past 5 years, the air defense missile combat environment has given rise to a great many changes. Aircraft are capable of low level night flight. In conjunction with that, use is made of long range laser guided bombs. Ballistic missiles are rapidly spreading to various nations of the world. They are already no longer the monopoly of a small number of superpowers. As a result, the concept of purely "anti aircraft" air defense is already obsolete. What is replacing it is that air defense systems must be able to handle various types of threats--including aircraft among them--in lower, higher, and more distant air space.

Fig.1 Israel's Balake (Phonetic) Missile in Flight

At the present time, various nations have all carried out improvements with regard to air defense missiles in order to increase their range, thereby strengthening the defensive capabilities of air defense missiles. A number of close range surface to air missile systems--for example, the new French generation of Sidewinder NG, the U.K.'s Long Sword, as well as Israel's Balake (phonetic), and so on, have gone through improvements, and ranges have been somewhat increased in all cases.

As far as increased surface to air missile range is concerned, it is necessary to correspondingly increase radar tracking range with respect to incoming attacking targets. As a result, another trend which is worthy of attention is that some air defense missile systems--for example, the Long Sword 2000--besides being fitted with a surveillance radar set and a tracking radar set--also have an automatic infrared tracking device. The latter possesses a capability for day or night acquisition and tracking of targets. The South African Kentron Company is in the midst of developing a type of infrared model Sahv radar. Its purpose is to reduce as

much as possible set on times associated with targets irradiating radars. Today, with air launched models of antiradar missiles already widely distributed, this is of critical importance.

Below are introduced the statuses of improvements and development associated with several types of surface to air missiles.

Fig.2 Long Sword 2000 Launch Vehicle. Carries Tracking Radar, Photoelectric/Infrared Tracking Devices, and 8 Missiles Waiting to Be Launched.

Sea Sparrow

The U.S. Raytheon Company's RIM-7 Sea Sparrow is one type of widely used shipborne medium range surface to air missile. It came from the development of the AIM-7 Sparrow air to air missile. The Sea Sparrow is already in 11 NATO nations as well as in naval service in Australia and Japan. A number of warships of the U.S., Canada, and Germany, by contrast, deploy a type of vertical launch system. The system in question makes use of missiles additionally fitted with series boosters and combustion gas modules to carry out initial control. The advantage of this type of vertical launch system is that it is capable of making use of large numbers of missiles waiting to be fired to carry out all around air defense. Their area of inadequacy is, by contrast, that the distance associated with flight to intercept point is slightly increased (when dealing with missiles in nap of the sea flight). In 1986,/35 the system in question went into service on the U.S. Navy's Bangkeshan (phonetic) (CG-52). In 1991, during the Gulf War, approximately 221 firings were carried out.

The RIM-7P (an improved model of the RIM-7M) which the U.S. is equiped with at the present time is in the midst of being replaced by RIM-7R which is fitted with infrared and semiactive radar dual mode guidance heads. Among the 13 nations which compose the NATO

Sea Sparrow financial group, there are 8 which have already agreed to make future improved models of the Sea Sparrow missile (ESSM). At present, the Raytheon Company and the Hughes Company are in the midst of competing for engineering and production phase contracts on the ESSM. ESSM will opt for the use of large thrust engines, thrust vector control systems, and a new guidance system in order to improve its capabilities with regard to handling supersonic missiles. According to plans, ESSM will possess initial combat capabilities in 1998.

Fig.3 Sea Sparrow Missile Launched from the Sea

Fig.4 Standard Long Range Ship to Air Missile Used by the U.S. and Other Countries

Although ESSM is improved on the foundation of RIM-7P or RIM-7R missiles, it will, however, strengthen middle phase guidance. In terms of aerodynamic lay out, the present variable angle of attack missile wings are replaced by tail fins. This is primarily in consideration of the fact that it uses large thrust rocket engines. ESSM will make use of a vertical launch system manufactured by the Martin Marietta Company for launches, becoming a primary means for warship antimissile defense. ESSM will also be able to develop into a new type of air to air missile.

What is worth bringing up is the fact that, in 1992, LTV Company put forward developing a type of warship defense missile which came out of the development of flight test prototyes from the

extended range interceptor (ERINT) antiballistic missile. It is said that it will be capable of becoming a candidate design or follow on model for the ESSM.

Standard Missile

As far as the RIM-66/67 Standard long range air defense missile is concerned, ever since its delivery and utilization in 1966, it has gone through 8 major upgrades. In 1987, the U.S. Navy selected the Raytheon Company to develop and produce the SM-2 Block 4 model Standard Missile. This missile is capable of dealing with targets flying at very high altitudes. It has a series booster unit, and, in conjunction with that, carries a thrust vector control system appropriate to launches from the Martin Marietta Company's vertical launching system. It is also appropriate for use on CG-47 cruisers, the U.S. Navy's DDG-51 destroyers, as well as a number of Canadian destroyers.

It is reported that, switching the front end of Standard missiles to the use of 256x256 unit infrared focal plane arrays and new guidance systems as well as kinetic energy kill and damage weapons weighing 18kg, they are then capable of becoming guided weapons of relatively low cost and able to deal with theater missiles.

Sea Javelin

The British GWS30 Sea Javelin and the U.S. Standard missile are similar. It provides surface protection for 12 British Royal Navy 42 Type destroyers and 3 Invincible Class aircraft carriers as well as 2 Argentine 42 Type destroyers.

The Sea Javelin opts for the use of semiactive radar guidance.

It is equiped with one ram jet main engine and has a range of over

Fig.5 British Aerospace Company Sea Javelin Missile

80km. Although the missiles in question stopped production in 1988, a series of improvements were, however, carried out again later. What rather attracts people's attention is its target irradiation radar and explosive fragmentation kill and damage warhead. Besides this, in approximately 1994, option will also be made for infrared proximity fuses. One important improvement project is also to begin around 1994. The implementation of the project in question is capable of making the Sea Javelin serve right on through around 2015.

NASAMS and MSAM

In the West, the development or improvement of a number of surface to air missiles is carried out around the AIM-120 Advanced Medium Range Air to Air Missile (AMRAAM). This type of air to air missile not only has a long range. Moreover, it opts for the use of inertial intermediate phase guidance and active radar terminal homing. On its foundation, it is possible to develop new models of medium range surface to air missiles.

Norway's NFT company and the U.S. Hughes company have jointly produced the Norwegian Advanced Surface to Air Missile System (NASAMS) on the foundation of AMRAAM. In the middle of 1992, the two companies discussed above--on the basis of a contract worth 79 million U.S. dollars--began production of equipment associated with two NASAMS batteries used in the air defense of Norway's main air force base in the south. In conjunction with this, Nike 2 model missiles were replaced. Preparations are also made to later use NASAMS equipment in 4-6 missile batteries used in the air defense of northern Norway. In conjunction with this, Norway's improved model Hawk missile (NOAH) is replaced.

Surface fired AMRAAM missiles are equiped with Husghes company TPQ-36A three dimensional radars and the NFT company's fire command post. The command post in question is capable of being positioned in areas 25km from firing systems. It is reported that one NASAMS missile battery is generally equiped with 4 radar sets and is capable of controling 9 firing systems mounting 6 together as well as L/70 guns. All 54 missiles are capable of being completely fired within 18 seconds. TPQ-36A radars are already used in Norway's improved model Hawk missile systems. They are capable of tracking 50 targets within a 70km range. In 1992, the U.S. Army procured approximately 152 TPQ-36A radars for forward area air defense systems (FAAD).

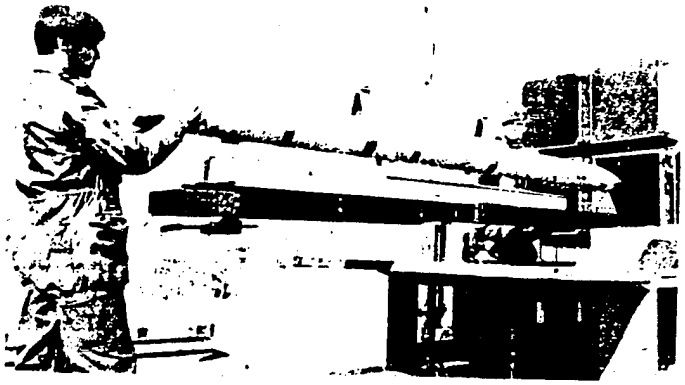

Fig.6 AMRAAM Missile Just in the Process of Loading onto a NASAMS Surface Launching System

Besides this, the Hughes company and the NFT company--also together with the Seimens company--produced, on the foundation of AMRAAM, a type of advanced surface to air missile system (ADSAMS) in order to satisfy requirements associated with the advanced surface to air missile which the U.K. uses (MSAM) replacing Police Dog missiles. The primary requirement with respect to MSAM is to be able to satisfy air defense requirements for East England and Lincolnshire Air Force airfields. In conjunction with this, it is capable of air transport deployment overseas. MSAM may be in service in the middle 1990's. This project is estimated with outlays of 1 billion U.S. dollars.

As far as the ADSAMS system is concerned, it will make use of a new generation of MSAM-1 missiles. The missiles in question opt for the use of AMRAAM missile guidance heads as well as electronic guidance devices and one large model rocket engine in order to increase range. The Seimens company--besides taking responsibility for the communications equipment between various sections of test manufactured weapons systems--also developed, in cooperation with the Hughes company, a type of active array high performance radar. Besides being capable of use in MSAM systems, this type of radar is also a piece of standard equipment in army level surface to air missile systems of the U.S. Army. The Seimens company also jointly developed with U.K. defense research agencies the MESAR (multiple function electronic scanning autoadaptive radar) radar.

ADSAMS systems will meet with two competitors. One is a system jointly developed by the Raytheon company and British Aerospace which combines the Long Sword 2000 and the Patriot. The other is a ground based medium range surface to air missile system (SAMP/T) developed by the European surface to air missile company.

Hawk

As far as the MIM-23 Hawk missile produced by the Raytheon company is concerned--since it was introduced into service at the end of the 1950's--more than 400 launcher systems and over 19000 missiles have already been produced. At the present time, this type of missile is still in service in the U.S. Army, U.S. Marine Corps, 8 member nations of NATO, as well as 13 other countries. The Hawk missile has shot down a MIG-25 fighter at 21000 meters altitude. In conjunction with this, matched up with the phase control array radar of the Patriot system, it has successfully intercepted tactical ballistic missiles. At the present time, improvements are still being carried out on the Hawk missile in ordert to improve its maneverability and survivability. It is estimated that, by 1995, a Hawk missile platoon's vehicles will be reduced from 21 at the present time to 10. /37

On the basis of plans at the present time, the U.S. Army is prepared to use army level surface to air missiles to replace the Hawk. The manueverability of army level surface to air missiles is better than Hawk. Counter jamming capabilities are stronger. They are capable of effectively dealing with ballistic missiles, pilotless aircraft, cruise missiles, and helicopters implementing surprise attacks.

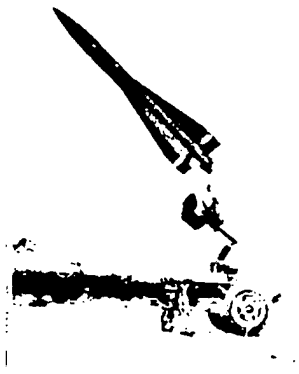

Fig.7 The U.S. Raytheon Company's Hawk Missile

Development of army level surface to air missiles was carried out on the foundation of the MIM-72G Little Oak short range (range of 15km) missile. However, it will opt for the use of a large thrust rocket engine to make its effective range increase to 25km or opt for the use of a solid ram jet rocket engine to make its range reach 40km. In the beginning, an 8 pack launcher system will be installed on the base plate of a standard M987. After that, it will be changed to two 6 pack launcher systems carried on an M933

(multiple launch rocket system vehicle). The M933 will be fitted with infrared search and tracking systems.

Asite (Phonetic)

Two nations of Europe--France and Italy--are just in the midst of jointly developing the modular type future surface to air missile family (FSAF) in order to replace such surface to air missiles as Hawk, Mashuka (phonetic), as well as the Tartar, and so on. The French astronavigation company took responsibility for developing two types of vertical launch missiles--the Asite (phonetic) 15 and the Asite (phonetic) 30. The characteristics of the two types of missiles are good interchangability, opting for the use of band target correction intermediate inertial guidance, active terminal homing guidance, jamming source homing systems, as well as control designs where aerodynamic forces and jet reacting forces are combined with each other.

Surface to air missile systems (SAAM) in FSAF are primarily used in dealing with supersonic, highly maneuverable missiles flying nap of the sea, as well as saturation attacks associated with missiles attacking at large dive angles--providing point defense for warships. The systems in question use Asite (phonetic) 15 missile 8 pack launching systems primarily. With regard to missiles, interception range is 5-15km. With respect to aircraft, interception range is 10-30km. SAAM/FR (French model) will replace the French Navy's Sidewinder. SAAM/IT (Italian model) will replace the Italian Navy's Albatross.

Land based medium range surface to air missile systems (SAMP/T) have the purpose of defending against cruise missiles and conventional aircraft. They will be used in order to replace Hawk.

The equipment of SAMP/T batteries is transported by wheeled type vehicles. They include 4-6 launcher systems (each launcher is equiped with 8 Asite [phonetic] 30 missiles). Various SAMP/T units can be dispersed within a range having a diameter of roughly 5km. As far as Asite (phonetic) 30 missiles are concerned, intercept range with regard to missiles is 10-20km. Intercept range with respect to aircraft is 25-80km. SAMP/T will serve in the French and Italian armies at the end of the 1990's.

Naval models of medium range surface to air missile systems (SAMP/N) are, at the present time, in design demonstration phase. SAMP/N makes use of Asite (phonetic) 30 missiles and EMPAR (European multiple function phase control array radar) radars. In severe jamming environments, they are capable of dealing with missile carriers within 70km. The systems in question will equip new models of air defense escort vessels. Each escort vessel carries 9 eight pack launch systems.

As far as the detailed status of relevent FSAF projects is concerned, please refer to the article "Franco-Italian Combined Implementation of FSAF Projects" in No.6 of this publication this year.

LAMS

LAMS (local defense missile systems) is a derivative system of SAMP/N. The U.K. is just in the midst of considering using it in order to replace the Sea Javelin. In conjunction with this, there is a possibility of equiping new model air defense escort vessels. Design demonstration work associated with LAMS projects is carried out cooperatively by the European surface to air missile company, the British Aerospace Company, as well as GEC-Makeni (phonetic) company. Warships which carry LAMS systems are capable of supplying air defense for vessels within a radius of 8km. LAMS adds a booster engine, thereby increasing acceleration capabilities. This is necessary for dealing with supersonic missiles. However, range is still shortened. Sometime later in 1992, the three nations of the U.K., France, and Italy combined to put forward an air defense requirement for a new model of escort vessel. This requirement may spur a combining of SAMP/N and LAMS. The European surface to air missile company will--on the basis of this--revise the engineering development plan. Germany is relatively interested in developing derivative models of SAMP/T to use in order to replace Patriot antimissile missiles. The design demonstration phase, which is scheduled to last not longer than 24 months, has already begun. According to plans, roughly 36 missile batteries and 2000 missiles will be in service in the year 2005.

From Patriot to ERINT and THAAD

The Raytheon company's MIM-104 Patriot missile is, at the present time, the only missile that possesses antimissile capabilities which have been proved. In 1991, during the Gulf War, PAC-2 model Patriot missiles shot down 45 Fleet Footed Runner (SCUD) missiles. The Patriot was originally designed in order to handle large scale saturation and surprise attacks by aircraft in severe electronic jamming environments. Following along with the development of the situation in air defense, interceptor missiles are clearly becoming more and more important. This then /38 requires that the Patriot must possess antimissile capabilities.

Fig.8 The Arrow Antimissile Missile Jointly Developed by the U.S. and Israel Just in the Midst of Carrying Out Flight Tests

In 1985, the implementation of PAC-1 and PAC-2 improvement projects began one after the other, making the Patriot capable of locking on and destroying incoming missiles. At the present time, the PAC-3 Patriot improvement project is still being carried out. In this project, Patriot missiles will opt for the use of a type of dual mode guidance head, providing C wave band semiactive guidance and K wave band active homing. PAC-3 model Patriots will be delivered this year. Following that, in the period 1994-1996, enhanced range interceptro (ERINT) with antimissile capabilities, the Arrow, as well as the theater high altitude air defense system (THAAD), and so on, will also be introduced into service one after the other.

At the present time, the U.S. Army is planning on having 104 Patriot launching units and 6077 missiles. Germany, Italy, Japan, Kuwait, Holland, and Saudi Arabia have all selected for use Patriot systems, thereby making the total number of Patriot missile systems reach 800 launching systems and over 7000 missiles.

ERINT is a type of high supersonic speed missile which opts for the use of active radar terminal homing and kinetic energy kill and damage. It was developed on the foundation of FLAGE experimental missiles (nimble, light, agile guided weapons). In the years 1986-87, FLAGE successfully carried out tests intercepting Lance missiles.

Arrow missiles are a type of antimissile missile jointly developed by the U.S. and Israel. It is said that its speed is 3 times that of the Patriot. Moreover, maneuver overloads can reach 160g. Sometime later in 1990, launch tests began to be carried

out. In conjunction with this, in the most recent interation of tests, a target missile was successfully intercepted.

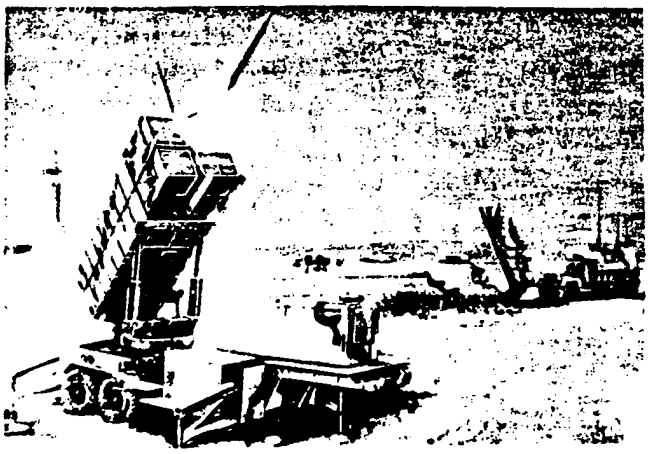

Fig.9 Enhanced Range Interception Devices Go Through Direct Collisions to Kill and Damage Targets.

Somewhat later in 1992, the U.S. Lockheed Co. and the U.S. Army signed a THAAD verification/evaluation contract expected to run 4 years and valued at 68.9 million U.S. dollars. THAAD is capable of being moved by Hercules transport aircraft. According to plans, the lay out with THAAD providing antimissile missile area defense and Patriot supplying antimissile missile point defense will be formed in a preliminary way by the beginning of the next century.

TWO U.S. COMPANIES STUDY RUSSIAN SPACESHIP AND ITS ROCKET ASSEMBLY PROBLEMS

He Bo

The U.S. General Dynamics Company and Martin Marietta Company will study, for the U.S. National Aeronautics and Space Administration, problems related to using their carrier devices to launch the independent itegrated body of the Union spaceship to act as assured component rescue vehicle (ACRV) for the Freedom space station. The U.S. National Aeronautics and Space Administration requires that the one time carrier devices studied be capable of taking a Union assured component rescue vehicle weighing approximately 7400 kg and sending it into a 190-240km high orbit with angle of inclination of 28.5°. The U.S. aviation and space agency also did research on building Freedom in an orbit with an angle of inclination of 51.6° in order to make use of Russian rockets to carry out service type launch plans. However, the government has still not made a decision at this point. These two companies as well as other bidders will analyze requirements associated with combining rockets with the Union, designate what kind of changes will be made in carrier craft, evaluate the nature of match ups between launch site facilities and systems and the Union, and, in conjunction with this, make precise determinations with regard to a standard carrier system in order to facilitate carrying out comparisons with other designs.

U.K. SELLS STARBUST SURFACE TO AIR MISSILES TO MALAYSIA

Ne Liang

At the end of January this year, the U.K. Xiaote (phonetic) Company sold Malaysia the Starburst short range surface to air missile. After making comparisions between two types of missiles--the U.S. Stinger and the U.K. Starburst--Malaysia selected the latter. The Starburst missiles which were sold to Malaysia in this instance are capable of being carried easily by Army infantry troops. Each launch rack is capable of mounting 3 missiles waiting to be launched.

Starburst Missile During the Gulf War

According to Xiaote (phonetic) Company introductions, the Starburst has the best performance among missiles of the same type in active service. It is capable of dealing with helicopters and jet fighters. The most important characteristic of the missile in question is its capability to carry out effective attacks against targets head on. Moreover, counter jamming (jammers, foil strips, infrared jamming, or electronic jamming) performance is good. In addition, it is capable of attacking aircraft opting for the use of stealth technology. During the missile's flight toward a target--when the identification friend or foe system on board the missile determines that a target is a friendly aircraft--it is capable of changing flight trajectory.

The Starburst missile is 1.4 meters long. It weighs over 20 kg. It came out of the development of the Javelin missile. Option is made for the use of laser beam guidance, increasing target acquisition probability. It possesses a very good cost benefit ratio. The missile in question opts for the use of improved type solid propellant. Ranges can reach 4 km--close to the Xibeifeng (Northwest Wind) missile.

Starburst missiles come in two models--land based types and warship based types. Among these, land based types are again divided into man portable and vehicle mounted types. On portable type launch racks, it is possible to mount 3 missiles awaiting firing in launch boxes. The British Army made use of this type of missile during the Gulf War. Malaysia is the Starburst's first foreign user.